BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED

Technical Specifications for Ring Main Units (RMU)

"Automation of NON-DAS feeders in BMAZ area".

Issued By

General Manager (DAS)

BESCOM

BESCOM Integrated Control Center-1, 17th

cross, 24th Main,

Sector-2, HSR layout

Bengaluru-560102

E-mail ID: gmdas@bescom.co.in

Mobile No.: 9448279010

Office No.: 080-22586356

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1 Introduction

This document contains the Technical Specifications that apply to **DAS Ring Main Units (3Way, 4Way & 5Way)** which covers the supply and installation of Ring Main Units (RMUs) within the BESCOM.

1.1 Key RMU Components

Key RMU components are listed as follows:

- Load break switches (LBSs) with earthing switches, also known as Operating Devices (ODs), connecting the RMU to incoming and outgoing main loop, 11 kV, 630 Amp capacity capable of connecting XLPE cables of size 400/240 Sqmm cross section aluminum conductor.
- Circuit breakers (CBs) corresponding to the configuration with Disconnector (Isolator) and earthing switch with three position switch, also known as Vertical Lines (VLs), connecting the RMU to distribution transformer loop (load center), 11kV, 630 Amp capacity of connecting to XLPE cables of size 95/240/400 Sqmm cross section aluminum conductor. SCADA compactable Numerical relays for overcurrent (OC) and earth fault (EF) protection in conjunction with the corresponding circuit breaker(s).
- SCADA compactable Fault Passage Indicator (FPI) in the RMU's outgoing main loop circuit to provide indications that feeder downstream phase or earth faults have occurred.
- All necessary voltage transformers and current transformers for metering and protection.
- All necessary dry (potential-free) contacts for indications relevant to RMU monitoring and control remotely.
- SCADA compactable multifunction meters serving as Intelligent Electronic Devices (IEDs) to provide voltage, current, power, energy, phase angle between voltage and current of all the three phases, power angle and power factor readings that correspond to the RMU's main-line circuits.
- A power supply unit, including auxiliary power transformer and battery backup, to provide stable 24 VDC source of power as necessary for the RMU's spring-charge motors, VPIS, FPI, relays, and multifunction meters. The power supply shall also provide for RMU enclosure lighting fixtures and power-plug receptacles for maintenance/test equipment and 12 VDC source of power for communication accessories.
- Capacitor voltage dividers serving live-line cable indicators with minimum one contacts for SCADA monitoring.

The RMU has six enclosures, one for each of the two load break switches, one for each of the three circuit breakers or VLs, and one for the RMU's auxiliary power supply unit and the necessary SCADA monitoring and control equipment. The SCADA monitoring and control equipment includes the RTU and communication accessories.

1.2 RING MAIN UNIT

Each RMU shall include its own power supply unit (including auxiliary power transformer, batteries, and battery charger), which shall provide a stable power source for not only the RMU, but also the RTU and communication accessories that the RMU must be capable of housing.

Each RMU shall be equipped with main-line load break switches and a fault passage indicator (FPI). Furthermore, to protect each of its lateral circuits, it shall be equipped with a corresponding set of circuit breakers and numerical relays. The RMU interrupters shall be enclosed in an SF_6 and the RMU will include all necessary voltage and current sensors and potential-free contacts so that, as a minimum, the DAS via its RMU remote interface can:

- Monitor and control the open/closed status of the RMU circuit breakers and load break switches.
- Monitor the local/remote position of RMU manually operated switches that can be used to enable and disable remote monitoring and control of individual ODs and VLs.
- Monitor the health of the power supply, which will include battery failure and low voltage indications and status of battery compartment.
- Monitor the open/closed status of RMU earthing switches & Disconnector.
- Monitor the open/closed status of RMU cable entry & Control Cabinet doors.
- Monitor for low SF_6 gas pressure.
- Monitor circuit breaker spring charge (switch readiness) status.
- Monitor for circuit breaker relay fault currents.
- Monitor for main-circuit fault currents detected by the FPI.
- Monitor for live line cable status for operation interlock.
- Monitor voltage, current, power, energy, and power factor values corresponding to the RMU's main circuits and the phase currents corresponding to the RMU's lateral circuits.
- Monitor the phase currents corresponding to the RMU's VLs.

1.3 Specification Organization

These Technical Specifications for DAS RMU are organized as follows:

- **Clause 1: RMU Design Features.** This clause includes design features related to RMU availability, maintainability, expandability, life span, and relevant physical and electrical properties.
- **Clause 2: RMU Characteristics.** This clause describes the main characteristics that relate to the functional and design aspects of RMU components such as line sensors, FPIs, protection relays, multi-function meters, motors, auxiliary transformers, power supply equipment, and enclosures.

1.4 Applicable Standards

The RMUs shall be manufactured to the highest quality consistent with best practice and workmanship and in full accord with the Contractor's quality assurance plan. The RMUs and the work associated with their installation shall also conform to the Indian and equivalent international standards that are applicable. These include the minimum required standards listed below:

The Contractor shall provide an English language copy of the applicable Indian and equivalent international standards met by the proposed RMU.

Table 1-1: Applicable Standards

Standard	Description
IS 3427	AC metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-1	High-voltage switchgear and control gear – Part 1: Common Specifications.
IEC 62271-200	International Standards for high voltage metal clad switchgear up to 52 KV.
IEC 62271-102	High-voltage switchgear and control gear - Part 102: Alternating Current disconnectors and earthing switches.
IEC 60529	Standard for Degrees of Protection Provided by Enclosures (IP Code).
IS 9920 (Parts 1 to 4)	High Voltage Switches
IS 9921 (Parts 1 to 5)	Specification for AC disconnectors and earthing switches for voltages above 1000 V
IEC 62271-100	Indian Standard for High-Voltage Alternating-Current Circuit-Breakers.
IS 10601	Dimensions of terminals of HV Switchgear and Control gear
IS 12729	General requirements of switchgear and control gear for voltages exceeding 1000 V
IS 2705	Current Transformers
IS 3156	Voltage transformers
IS 3231	Indian Standards for electrical relays used in power system protection
IEC 60255	Measuring relays and protection equipment

1.5 Environmental Conditions

All materials supplied and installed shall be capable of operating without fault in a tropical climate, which exhibits a high level of ultra-violet radiation and severe thunderstorms. Relevant environmental conditions are listed as follows:

- Maximum ambient air temperature : 50 ºC
- Minimum ambient air temperature : 10 ºC
- Maximum relative humidity: 90 %
- Average thunderstorm days per annum: 50

- Average rainfall per annum: 900 mm
- Maximum wind speed: 119 km/hr
- Altitude above mean sea level: 1000 m

1.6 Distribution Network Electrical Parameters

The main parameters of the distribution network are as follows:

- Nominal system voltage: 11 kV (rms)
- Highest system voltage: 12 kV (rms)
- Number of phases: 3
- Frequency: 50 Hz
- Variation in frequency: 49 Hz to 50.5 Hz
- Type of earthing: Solid
- Power frequency withstand voltage: 28 kV
- Basic impulse withstand voltage : 75 kV

2 RMU Design Features

All design features of the proposed RMU, shall be fully supported by the equipment actually delivered. The key design features include those that relate to:

- Availability, maintainability, expandability and life span
- Ability to operate in severe outdoor environmental conditions
- Immunity to electrical stress and disturbance
- Acceptable insulation properties
- Acceptable surge suppression characteristics
- Convenient RTU interconnection features

In these and all other specified respects, the RMU shall meet or exceed the cited standards or, where appropriate, other equivalent industry standards.

2.1 Availability, Life Span, Maintainability and Expandability

2.1.1 Availability

The RMU shall be designed to have fully enclosed metal housing combined with the single-phase insulation of all primary live parts to reduce the risk of internal faults to an absolute minimum and to provide a high degree of safety as well as availability. Nevertheless, manufacturer standard designs shall be used to the fullest extent possible.

Each RMU shall exhibit an availability of greater than 99.5%. To ensure this high degree of availability, the RMUs shall be fabricated, assembled, and finished with workmanship of the highest production quality and shall conform to all applicable quality control standards. All materials comprising the RMU shall be new, unused, and of the best industrial grade, and the RMU shall incorporate all recent

improvements in both design and materials. All components shall be of current production from **reliable/reputed component manufacturers. Quality of the component and availability shall meet life span of the equipment.**

2.1.2 Life Span

Each RMU shall have a design life **of at least 20 years from the date of commission.** The contractor shall make available, at no cost to the BESCOM, the manufacturing designs, drawings, and the rights to manufacture any subassemblies that the manufacturer will not support or discontinue to support during this life span. The specific components of each sub-assembly shall be identified and submitted by **Contractor.**

2.1.3 Maintainability

The BESCOM intends to be self-reliant for RMU maintenance. To this end, the Contractor shall provide the support, documentation, and training necessary to operate and repair the RMU. This shall include, but shall not be limited to the maintenance manuals and repair kits applicable to the Contractor's RMU design. Details of the proposed repair kits shall be provided.

The BESCOM prefers RMU designs **that do not require periodic preventive maintenance** upto defect liability period. If periodic maintenance is required within this period, it shall be possible to perform all such work in the field without extra cost to BESCOM.

To facilitate expansion and maintenance, modularity shall be employed in the design of the equipment. All major subassemblies shall carry permanent labels providing a cross-reference to the Contractor's corresponding documentation.

2.1.4 Expandability

The RMUs shall be designed such that, in the future, they can be expanded to accommodate additional enclosures containing circuit breakers and associated equipment that will allow the RMU to supply power to additional distribution circuits. In this respect, for example, the 3-way, 4Way RMU shall be expandable in the field to a 5-way RMU.

2.2 Outdoor Features

2.2.1 General

The RMUs shall be designed specifically for outdoor installation and, in this respect, shall be suitable for continuous operation in a tropical climate that includes exposure to severe frequently occurring thunderstorms. They shall also be suitable for conditions in which they will be exposed to heavy industrial pollution, salt-spray, and high levels of airborne dust.

The equipment in the proposed outdoor RMU shall be conformably coated to meet these climatic conditions. In this respect, standard IEC covering equipment, systems, operating conditions, and environmental conditions which covers the classification of such conditions.

In addition to the above, materials promoting the growth of fungus or susceptibility to corrosion and heat degradation shall not be used, and steps shall be taken to provide rodent proof installations.

2.2.2 Corrosion Protection

Except for stainless steel, all steel surfaces that are not galvanized shall be treated to protect against corrosion. As a minimum, corrosion treatment shall include the following procedures:

- The surface shall be cleaned to bare material by mechanical or chemical means.
- One or more phosphatizing or priming coats of paint shall be applied to the bare surface using a zinc-based or epoxy primers.
- A finish coat with high scratch resistance or epoxy powder finish paint shall be applied over the primer. The coat thickness shall be 120 micrometers.
- The finish-coat color should be RAL-7032.

2.2.3 Galvanizing

Except for stainless steel, and unless otherwise stated, all structural steel and all exterior and interior steel surfaces of the RMUs, as well as nuts and bolts associated with galvanized parts, shall be hot-dipped galvanized in accordance with IS 802 or an equivalent international standard.

2.3 Immunity to Electrical Stress and Disturbance

The electrical and electronic components of the RMU shall conform to relevant standards concerning insulation, isolation, and immunity from electromagnetic interference, radiated disturbance, and electrostatic discharge. The ability to meet these requirements shall be verified by type tests carried out by accredited test laboratories that are independent of the bidder and/or the manufacturer of the RMU components. Certified copies of all available type test certificates and test results shall be included as a part of bidder's proposal. Failure to conform to this requirement shall constitute grounds for rejection of the proposal.

2.4 Minimum Insulation of Equipment

The RMUs shall be of SF_6 gas-insulated type. Otherwise, from an insulation perspective, the RMU shall be designed so as to minimize exposure to electrically live terminals when visual inspection or maintenance of the internal components is being conducted.

2.5 Surge Voltage Suppression

The RMU shall be designed to operate on input power containing voltage spikes. Equipment shall be protected against part failure or malfunction such as intermittent firing of triggering devices due to surge voltage spikes occurring randomly over the instantaneous supply voltage. Dedicated Surge Protection Devices (SPDs) shall be provided to RS-485 Meter-Relay communication ports

2.6 Nameplate Information

RMU nameplate information shall be as specified in the relevant IEC standards (IS 12729:2004 & IS/IEC 62271-200:2003) along with following additional information:

- Name of manufacturer and country
- Type, design, and serial number

- Rated voltage and current
- Rated frequency(f)
- Rated short duration power frequency withstand voltage (Ud)
- Rated lightning impulse withstand voltage (Up)
- Short time withstand current and its duration.
- Rated symmetrical breaking capacity
- Rated making capacity
- Auxiliary control voltage (Ua)
- Internal Arc Classification.
- Operating cycle
- Month and year of supply
- Purchase Order number and date
  Project details
- Height and Weight of the RMU
- SF6 pressure details.
- Protection relay details

The name plate and a BESCOM logo shall be engraved with all the above information and Each RMU shall also exhibit a Danger Board to indicate the presence of high voltage (11,000 V).
The nameplates of each functional unit shall be legible during normal service. The removable parts, if any, shall have a separate nameplate with the data relating to the functional units they belong to, but this nameplate need only be legible when the removable part is in the removed position.

For outdoor switchgear and control gear, the nameplates and their fixings shall be weatherproof and corrosion-proof. If the switchgear and control gear consist of several poles with independent operating mechanisms, each pole shall be provided with a nameplate.

2.7 Interconnecting Cables, Wiring, Connectors, and Terminal Blocks

The contractor shall provide all interconnecting wires, cables, connectors, terminations and other wiring accessories such as terminal blocks required by the RMU.

2.7.1 Metallic Cables

All metallic cables and wiring shall be of required cross-section solid or multiple strands of round copper conductors and have flame retardant insulation. All wiring shall be neatly laced and clamped.

All wire and cable connectors and terminators shall be permanently labeled for identification. All connection points for external cables and wires shall be easily accessible for connection and disconnection and shall be permanently labeled. Conductors in multi-conductor cables shall be individually color-coded.

2.7.2 Connectors

Plug-type connectors with captive fasteners shall be used for all interconnections. The connectors shall be polarized to prevent improper assembly.

2.7.3 RMU-RTU Connectors

For ease of installation and maintenance, the interconnection between the RMU and the RTU, i.e., the RTU to be installed by others in a separate RMU enclosure with dedicated access door shall be

supported by having a multi-pin connector.

To accommodate all of the RMU equipment points to be monitored and controlled, the connector installed in the enclosure (the Control Cabinet) containing the RTU interconnecting the RMU and RTU shall consist of six (6) multi-pin connectors irrespective of RMU configuration (Up to 5Way).

Final connector, cabling, and cable routing details shall be determined during the Project's Engineering stage. In this respect, however, the following concepts shall apply:

- The Control Cabinet's fixed connector shall consist of 6 individual multi-pin connectors having 24 female inserts and contacts capable of being wired to the RTU and to single multi- pin connectors of female type fixed within the other RMU enclosures via separate hooded plugs having 24 male inserts and contacts attached to cables of suitable length. The RTU 24Pin male connector and its cable will be provided by the RTU Vendor.
- All cabling for the RMU's analog and status input points, control output points, and auxiliary contacts shall be brought out to the single multi-pin connectors through Terminal Block through wire protector cable sleeves in the RMU enclosures.
- The female multi-pin connectors shall contain a locking lever so that, in combination with the male connectors, they shall act as a mechanical locking device between male and female connector pairs. The lever shall only be fully locked if the two connectors are mated correctly.

2.7.4 Terminal Blocks

Apart from the connectors described above, heavy-duty terminal blocks with screw type terminals for 5mm minimum size machine screws shall be provided for other necessary metallic cable terminations. Terminals for auxiliary relays shall equal or exceed the relay wiring requirements. In using a terminal block, **no more than two cables or wires** shall be connected to any of its individual terminals.

Self-extinguishing fireproof vinyl marking strips shall be used to identify all external connection blocks. Marking tags shall be read horizontally. All terminals to which battery or other high voltages are connected shall be provided with fireproof covers.

All individual status input, AC voltage input, and control output points shall be isolatable without the need to remove wiring by means of individual terminal blocks of the removable link type. In order to

avoid open circuits on the secondary side of CTs, termination blocks with by-pass bridges shall be provided for all AC current inputs. MFM and Relay Communication RS-485 cable wiring shall be terminated on terminal blocks,

Terminal blocks shall comply with latest IEC 60947-7-1nstandards.

Table 2-1 RMU/RTU Connector Pin-Out

Pin Nos		LBS 1 (OD 1)	Pin Nos		LBS 2 (OD 2)	Pin Nos		Miscellaneous	Pin Nos		CB 1 (VL 1)	Pin Nos		CB 2 (VL 2)	Pin Nos		CB 3 (VL 3)
1	2	LBS 1: closed	1	2	LBS 2: closed	1	2	SF6 pressure: low	1	2	CB 1: closed	1	2	CB 2: closed	1	2	CB 3: closed
3	4	LBS 1: open	3	4	LBS 2: open	3	4	Charger AC: fail	3	4	CB 1: open	3	4	CB 2: open	3	4	CB 3: open
5	6	LBS 1: VPIS Indication	5	6	LBS 2: VPIS Indication	5	6	Voltage DC: low	5	6	CB 1: Spring/Motor charged	5	6	CB 2: Spring/Motor charged	5	6	CB 3: Spring/Motor charged
7	8	LBS 1 Earth switch: closed	7	8	LBS 2 Earth switch: closed	7	8	Battery: fail	7	8	CB 1 Earth switch: closed	7	8	CB 2 Earth switch: closed	7	8	CB 3 Earth switch: closed
9	10	LBS 1 Earth switch: open	9	10	LBS 2 Earth switch: open	9	10	Battery temperature	9	10	CB 1 Earth switch: open	9	10	CB 2 Earth switch: open	9	10	CB 3 Earth switch: open
11	12	Spare	11	12	FPI: OCR operated	11	12	CC Door: open	11	12	CB 1: VPIS Indication	11	12	CB 2: VPIS Indication	11	12	CB 3: VPIS Indication
13	14	DI indication for execution of DO command for open and close of LBS 1	13	14	FPI: EFR operated	13	14	Battery Compartment Door Open	13	14	DI indication for execution of DO command for open and close of CB 1	13	14	DI indication for execution of DO command for open and close of CB 2	13	14	DI indication for execution of DO command for open and close of CB 3
15	16	LBS 1: L/R Switch Local Status	15	16	LBS 2: L/R Switch Local Status	15	16	DI indication for execution of DO command for open and close of LBS 2	15	16	CB 1: L/R Switch Local Status	15	16	CB 2: L/R Switch Local Status	15	16	CB 3: L/R Switch Local Status
17	18	LBS 1 Control: close	17	18	LBS 2 Control: close	17	18	Hooter Reset	17	18	CB 1 Control: close	17	18	CB 2 Control: close	17	18	CB 3 Control: close
19	20	LBS 1 Control: open	19	20	LBS 2 Control: open	19	20	Spare	19	20	CB 1 Control: open	19	20	CB 2 Control: open	19	20	CB 3 Control: open
21	22	LBS 1: Cable entry Door open	21	22	LBS 2: Cable entry Door open	21	22	Spare	21	22	CB 1: Cable entry Door open	21	22	CB 2: Cable entry Door open	21	22	CB 3: Cable entry Door open
23	24	Spare	23	24	FPI: Remote reset	23	24	Spare	23	24	CB 1 Disconnector: open/close	23	24	CB 2 Disconnector: open/close	23	24	CB 3 Disconnector: open/close

*** MFM and Relay parameters are controlled through Modbus. Hence these points are kept out of Pin out.**

3 RMU Characteristics

As a minimum, the RMUs shall be equipped with main-line load break switches and a fault passage indicator (FPI), circuit breakers, and numerical relays for the protection of laterals, and multifunction meters providing voltage, current, power, energy, and power factor readings. The Load Break Switches and the Circuit Breakers used in the RMU shall SF_6 insulated and Vacuum interrupter type.

In addition, each RMU shall be equipped with all necessary connectors, terminal blocks, and other accessories that will allow to send required RMU/distribution network indications and measurements to the DAS via RTU and the communications system.

3.1 General Requirements

Each RMU shall include its own power supply, including battery and battery charger, and provisions for supplying a stable source of power for the RTU and communication accessories to be housed by the RMU. Thus, the RMU shall also provide the necessary space for housing the RTU and communication accessories. In addition, space must be provided for the RMU's auxiliary power transformer, which shall serve as the power supply's 230 VAC input, along with all other RMU devices such as the PTs and CTs for deriving voltage and current signals.

Within this context, the general requirements of the RMU shall include, but shall not be limited to provision of the following monitoring and control features:

- Positions of local/remote switches as used to control local and remote access to circuit breakers and load break switches.
- Power supply indications including AC fail, Battery failure and DC voltage Low alarms.
- Open/closed position of load break switches, circuit breakers and its Disconnectors and earthing switches.
- Enclosure (Control Cabinet/Cable Entry) door-open indications
- Battery Compartment door-open alarm indications and Hooter remote reset.
- SF_6 gas-pressure low alarm.
- Circuit breaker spring charge (switch readiness) indications.
- Circuit breaker fault indications by relay, Relay trip, latch Reset and Relay setting control through Modbus.
- Indications of fault current in the RMU's main feeder circuit as detected by the FPI and FPI remote reset.
- Measurement of 11 kV voltage, current, power, energy, phase angle, power factor and other 11kV network Parameters.
- Load break switch and circuit breakers open and close control.
- Status of Live line indications through VPIS (SCADA enabled).

3.2 Parameter Requirements

The RMUs shall be suitable for 630 Amps. The minimum design parameters to which their major components shall conform or exceed are summarized in the following tables.

Table 3-1: System Parameters

Parameter	Value
Nominal System Voltage	11 kV
Highest System Voltage	12 kV
System frequency	50 Hz
Number of Phases	3 Phase

Table 3-2: Circuit Breaker Parameters

Parameter	Value
Lightning Impulse Withstand Voltage Phase-to-Phase & Phase-to- Earth: Across Isolating Distance:	75 kV (peak)
Power Frequency Withstand Voltage to Earth, Between Poles, & Across Opening Span Across Isolating Distance	28 kV rms for 1 minute
Rated Short Time Withstand/Breaking Current:	AFLR for RMU SF6 Tank and Cable Chamber-IAC AFLR 21kA 1Sec.
Rated Duration of Short Circuit:	3s seconds
Rated Normal Current:	630 Amps (rms)
Total Break time	25-30 msec

Table 3-3: Load Break Switch Parameters

Parameter	Value
Rated Short Circuit Making Capacity	52.5 kA peak at rated voltage (both LBS, Disconnector & Earthing Switch)
Rated Load Interrupting Current	630 Amps
Rated Cable Charging Interrupting Current	25 Amps

The RMU shall be capable of withstanding the specified currents without damage and in accordance with IEC 62271-102 and IEC 62271-1 (Common Specifications for High-Voltage Switchgear and Control Gear Standards) and IS 3427 (AC Metal Enclosed Switchgear and Control Gear for Rated Voltages above 1 kV and up to and including 52 kV). The rated cable charging interrupting current shall be 25Amps as per IEC62271-103

3.2.1 Design Details

- The RMU shall be designed to operate at the rated voltage of 11 kV. It shall consist of two (2) numbers of 630 Amp SF_6 insulated Load Break Switches as incomers and up to three (3) numbers of 630 Amp SF_6 insulated Circuit Breakers.

  The SF6 gas chamber shall be of stainless steel 316L grade with a minimum thickness of 2.5mm and copper bus bar of suitable size required for 630A shall be provided as per applicable IEC standardIt

shall include, within the same metal enclosure, earthing switches for each Load Break Switch and earthing switches and disconnector for each Circuit Breaker.

- Suitable fool-proof interlocks shall be provided to the earthing switches to prevent inadvertent or accidental closing when the cable is in charged condition and Opening cable entry door as per VPIS indication (i.e when VPIS is in ON condition).
- Circuit breaker Disconnectors, the operating mechanism shall include manual operating facilities, position indication, interlocking, and fail-safe operation in the event of auxiliary power loss.
- The active parts of the switchgear shall be maintenance free. Otherwise, the RMU shall be of low-maintenance type.
- The degree of protection required for SF6 gas insulated chamber against prevailing environmental conditions, including splashing water and dust, shall be not less than IP 67 or better.
- The tank shall be made of an adequate thickness of stainless steel and shall be internally arc tested.
- The RMU shall be suitable for mounting on its connecting cable trench.
- For each RMU enclosure, a suitably sized nameplate clearly identifying the enclosure and the electrical characteristics of the enclosed devices shall be provided.
- The positions of the different devices shall be clearly visible to an operator when standing in front of each enclosure with its door open. Device operations shall be clearly visible.
- The RMU design shall be such that access to live parts shall not be possible without the use of manufacture-supplied tools.
- The design shall incorporate features that prevent any accidental opening of the earth switch when it is in the closed position.
- Similarly, accidental closing of a Circuit Breaker or Load Break Switch shall be prevented when the same is in an open position. This includes protection against accidental closing resulting from the release of any latch or spring in tension due to vibrations caused externally or internally.
- The operating mechanisms shall be designed and positioned such that they do not exert any leaning or undue pressure on the enclosure, ensuring structural integrity and safe operation.
- The opening between Feeder compartments and Control cabinet compartments shall be made vermin proof.
- A number lock/Digital lock of adequate size shall be provided to RTU Control Cabinet.
- Control Cabinet shall include a minimum contiguous space for installation of RTU. The final physical dimensions for installation of RTU shall be finalized during the design phase.
- A suitable provision shall be made to replace only metallic portion of bushing/ part of Bushing without opening of the SF6 chamber, when cable bushing threads are burnt out. The design should ensure that the replacement process does not compromise the sealing integrity of the SF6 gas chamber.
- Minimum gap between bushing to bushings inside all the cable compartments for proper cable termination shall be 110mm.
- Minimum gap inside all the cable compartments will be finalized during design stage.
- To avoid opening of Battery compartment by un-authorized personnel a theft proof

arrangement along with annunciation with alarm sufficient decibel shall be provided.

- Access to the battery compartment shall be secured by a tamper-proof locking mechanism with sturdy enclosure. Unauthorized opening shall be detected and shall activate a local audible annunciation system with a sound level not less than 100 dB. Provision shall be made to monitor unauthorized opening and reset the activated annunciation system remotely.

3.2.2 Earthing

- There shall be continuity between metallic parts of the RMUs and cables so that there is no dangerous electric field in the surrounding air and the safety of personnel is ensured.
- The RMU frames shall be connected to the main earth bars, and the cables shall be earthed by an Earthing Switch having the specified short circuit making capacity.
- The Earthing Switch shall be operable only when the main switch is open. In this respect, a suitable mechanical fail-proof interlock shall be provided.
- The Earthing Switch shall be provided with a reliable earthing terminal for connection to an earthing conductor having a clamping screw suitable for the specified earth fault conditions. The connection point shall be marked with the earth symbol. The flexible connections between the earthing blade and the frame shall have a cross-section of at least 50 mm^2 copper or equivalent in aluminum.
- The Earthing Switch shall be fitted with its own operating mechanism. In this respect, manual closing shall be driven by a fast acting mechanism independent of the operator's action.

3.2.3 Incomer Load Break Switches

- The Load Break Switches shall be maintenance free. With enclosure doors open, the position of power contacts and earthing contacts shall be clearly visible from the front of the RMU.
- The position indicator shall provide positive contact indication in accordance with IS 9920. In addition, the manufacturer shall prove the reliability of indication in accordance with IS 9921. These switches shall have three positions (or states), i.e., Open, Closed, and

  Earthed, and shall be constructed in such a way that natural interlocking prevents unauthorized operations.
- The switches shall be fully assembled, tested, and inspected in the factory.
- Manual opening and closing shall be driven by a fast-acting mechanism independent of manual operator action.
- The Load Break Switches shall be provided with a motorized operating mechanism suitable for SCADA control.
- A facility shall be provided with an electrical operating mechanism allowing an operator at the RMU site to operate the Load Break Switches without any modification of the operating mechanism and without de-energizing the RMU.

3.2.4 Circuit Breakers

The Circuit Breakers shall be maintenance free and, when standing in front of the RMU with enclosure doors open, their positions shall be clearly visible. The position indicator shall provide positive contact indication in accordance with IS 9920. In addition, the manufacturer shall prove the reliability of indication in accordance with IS 9921: Alternating Current Disconnectors (Isolators) and Earthing Switches for Voltages above 1,000 V.

The breakers shall have Two positions (or states), i.e., Open & Closed and shall be constructed in such a way that natural interlocking prevents unauthorized operations. They shall be fully assembled, tested, and inspected in the factory.

An operating mechanism shall be used to manually close the Circuit Breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping. The Circuit Breaker shall be capable of closing fully and latching against the rated making current. Mechanical indication of the OPEN & CLOSED positions of the Circuit Breaker shall be provided.

When the Circuit Breaker closing mechanism is of the spring-operated type, it shall not be possible for the Circuit Breaker to close until the spring is fully charged and the associated charging mechanism is fully ready for closing. Wherever an external spring charging handle is required to charge the spring, it shall be ensured that the same is not allowed to move during release of the spring energy. Alternatively, it shall not be possible to release the spring energy until the charging handle is completely disengaged from the mechanism. A visual mechanical indicating device shall be provided to indicate the status of the spring, i.e., SPRING CHARGED or SPRING FREE. It shall be possible to charge the spring when the Circuit Breaker is closed and, if the spring is released, the Circuit Breaker shall not open, nor shall this operation result in any mechanical damage to the component of the Circuit Breaker or its operating mechanism. A fast-acting reflex mechanism for Circuit Breakers is also acceptable.

Each Circuit Breaker shall operate in conjunction with a suitable protection relay under lateral circuit phase and earth fault conditions. In addition, the Circuit Breaker shall be provided with a motorized operating mechanism that can be remotely controlled by the DAS. The Motors shall be within the enclosures.

3.2.5 Cable Termination

Bushings shall be conveniently located for working with the specified cables and shall allow for the termination of these cables in accordance with the prevailing practice and guidelines of cable manufacturers. The dimensions of the terminals shall be in accordance with IS 10601. Cable compartment shall have enough space for ease of cable termination work according to 400sqmm XLPE cable bending radius. A non-Ferro-magnetic cable clamp arrangement shall be provided for each cable to be terminated in the RMU.

A provision shall be made to replace only metallic portion of bushing/ part of Bushing without opening of the SF6 chamber, when cable bushing threads are burnt out.

A suitable arrangement for the Circuit Breakers, Earthing Switches, and Load Break Switches shall be provided so that these devices can be padlocked in the "Open" and "Closed" positions.

A permanent "Live Cable" indication as per IEC 61958 (High-Voltage Prefabricated Switchgear and Control Gear Assemblies - Voltage Presence Indicating Systems) shall be provided for each cable using a capacitor voltage divider suitable for SCADA. Potential free contacts shall be provided with VPIS for remote monitoring.

It shall be possible to test the core or sheath insulation of the cables without de-energizing the remaining section of the RMU, accessing the cable compartment, or disconnecting the cable.

3.2.6 Safety of Equipment

With respect to the RMU's SF_6-filled equipment, any accidental overpressure inside the sealed chamber shall be limited by the opening of a pressure-limiting device in the enclosure so that the gas will be released away from the operator without endangering the operator or anyone else in the vicinity of the RMU.

3.2.7 Front Plate

The front plate shall include a clear mimic diagram indicating RMU functionality. The position indicators shall correctly depict the position of the main contacts and shall be clearly visible to the operator. The lever operating direction shall be clearly indicated. Mimic diagram shall be resistant to scratches and cleaning chemicals, also UV resistant and non-fading. It shall be fixed or embossed permanently on the RMU front door.

3.3 Line sensors

The RMU shall be provided with current sensors and voltage sensors. These sensors shall meet the electrical and mechanical ratings as per the relevant standards.

3.3.1 Current Transformers

A panel shall be provided in each load break switch enclosure to mount a three-phase, single-core, CT for metering purposes. A similar panel shall be provided in each circuit breaker enclosure to mount a three-phase, single-core, CT for protection purposes. CT access for maintenance or any other purpose shall be from the front panels.

The CTs shall conform to IS 2705. The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitably to a terminal block, which will be easily accessible for testing and terminal connections.

Further, the CTs shall be single core or multi core, the characteristics and features distinguishing CTs used for metering and CTs used for protection are listed as follows:

CTs for Metering:

- Material: Epoxy resin cast
- Burden: 2.5VA
- Ratio: 400-200/1 A
- Accuracy Class: 0.2

CTs for Protection:

- Material: Epoxy resin cast
- Burden: 5VA
- Ratio: 200-100/1 A Accuracy Class: 5 P 20.

The RMU's other CTs, i.e., those used by Fault Passage Indicators (FPIs), shall be supplied by the FPI manufacturer. These CTs shall be an integral part of the FPI's design to ensure that they properly match the requirements of the FPI.

3.3.2 Voltage Transformers

Potential transformers shall be provided. The burden per transformer shall be no more than 50 VA and the voltage ratio shall be 11kV/√3/110V/√3. The accuracy class shall be 0.2. HRC fuses shall be provided on the HV side. Secondary terminals shall be brought out suitably to a terminal block, which will be easily accessible for testing and terminal connections

The PTs shall be of cast epoxy-resin construction, and they shall conform to IS 3156. Their design and construction, in particular, shall be sufficiently robust to withstand the thermal and dynamic stresses during short circuits.

3.4 Fault Passage Indicator

Each RMU shall be outfitted with one non-communicable FPI. The FPI shall be mounted in the nominal outgoing OD (Load Break Switch) enclosure along with its integral CT for phase and earth fault monitoring.

The FPIs shall include:

- Fault indicator units for feeder phase and earth faults.
- Potential-free output contacts for hardwiring to RTUs. On this basis, the DAS will be able to monitor fault passage indications. Two such output contacts per FPI are desirable, one for phase and one for earth fault monitoring.
- Potential-free input contacts for hardwiring to RTUs to allow the DAS to reset FPI's following their detection of phase or earth faults.
- Configuration ports for configuring the equipment in the field.
- FPI shall be powered by RMU axillary power supply unit and backup battery shall be provided in case of power failure.

Local fault indications shall be provided in addition to remote indications through the RTU. The local indications shall use LEDs on the front panel of the RMU enclosure.

The characteristics of the FPIs shall include:

- Phase fault thresholds configurable from at least 250 to 625 A
- Earth fault thresholds configurable from at least 40 to 100 A
- Number of steps for adjusting phase and earth fault thresholds at least four
- Fault current duration range configurable from at least 40 ms to 500 ms in 20 ms steps

Variations with respect to these characteristics may be acceptable as long as they prove applicable and provide the same or better flexibility.

3.5 Protection Relay

The RMU shall be equipped with SCADA based self-powered draw out type numerical relays as used to trip the RMU circuit breakers.

3.5.1 General

- The Circuit Breaker enclosures in the RMU shall be outfitted with a communicable-type numerical self-powered draw out type relay, i.e., one for each outgoing circuit breakers. The relay shall interface with the RTU via RS485 port in order to send, receive or configure parameters, to provide status and control the relay reset in real time and shall have the capability of time synchronization from RTU using the Standard MODBUS protocol address defined by BESCOM.
- A flag indicator shall be installed for signaling the occurrence of trip conditions.
- The Relay shall be provided with internal rechargeable battery as a backup.

The numerical relay shall be powered by the RMU's power supply unit and be provided with Inverse Definite Minimum Time (IDMT) Characteristics and **Instantaneous protection characteristics.** On this basis, the relay as a minimum shall provide:

3.5.2 Phase Overcurrent Protection (50/51) Earth Fault Protection (50N/51N) Features and Characteristics

The numerical relay shall have the following minimal features and characteristics noting that variations may be acceptable as long as they provide similar or better functionality and/or flexibility. It shall be housed in a flush mounting case, draw out type and powered by the RMU power supply unit also.

- The Relay shall have capability to display currents from 1Amps.
- It shall have three phase overcurrent elements and one earth fault element.
- IDMT trip current settings shall be 10-250% in steps of 1% for phase overcurrent and 5- 250% in steps of 1% for earth fault. The Time Multiplier Setting (TMS) shall be adjustable from 0.01s to 2.5s in 0.01s steps.
- Instantaneous trip current settings shall be 50-3000% in steps of 50% for phase overcurrent and 50-1500% in steps of 50% for earth fault. The Time element shall be adjustable from 0s to 20s in 0.01s steps.
- Instantaneous characteristics: The Time Element should start from"0" (zero value), type test reports are required, that how much time will relay take to trip with Time Element "0" and also with Time delay when the fault current is injected in multiples of the rated CT.
- Selectable IDMT Standard IEEE/ANSI/US/IEC curves shall be provided, for example, Normal Inverse (3.0, 1.3), Very Inverse, Extreme Inverse, Long Time Inverse, Moderate inverse, short time inverse and Definite Time. Separate curve settings for phase overcurrent and earth fault shall be supported.
- The relay shall have local independent LED indications for Healthy, Trip, Pickup, Block, CBFP, L1, L2, L3 and E, Healthy/ Hardware error.
- Relay reset provisions shall be provided from SCADA center through Modbus communication.
- The relay shall also be provided with:
  - Cold load pickup protection features shall be provided separately (The range shall be considered same as of IDMT and Instantaneous characteristics). It should be independent of protection settings (Group1 and Group 02 relay settings).
  - Circuit breaker failure protection(CBFP) feature shall be provided (The Time delay range 0.05-2sec in steps of 0.01 sec)

- The fault current sensing feature in relay shall be implemented as per standards.
- Phase Angle: This feature shall be included in relay
- Active group feature for group selection to be included
- Total Break time : This feature shall be included in fault records of relay which includes Relay fault sensing time, Relay operating time, arc quench time and breaker open time (Fault Clearance time) i.e. total time required to clear the fault to be recorded in relay fault current records.
- LCD Display for measurement and relay setting.
- Communications via MODBUS RS485 port to provide the RTU (and hence the DAS) with all phase currents and Ie measurements. It is also desirable that this same means of communication can be used by the RTU to send setting and control commands to the relay through Control center (DAS).
- Front USB port for local communications with a laptop, PC, front end software have to be provided.
- Parameter change capability that is password protected.
- Capability to record up to 20 of the latest fault records duly time stamped and stored in non-volatile memory for subsequent reading via the above referenced USB port.
- Relays shall be of 24 V DC auxiliary type.
- Relay should have facility to Relay trip & latch Reset and Relay setting control through Modbus.
- The RTC back up battery shall be maintenance free and life span shall be minimum 10yrs and easily replaceable.
- Boot up time of the relay in the absence of external supply/Battery backup should be minimum.
- Any omission, ambiguity, or lack of detail in this specification shall not relieve the Contractor of the responsibility to provide complete and fully functional protection schemes. The Contractor shall be deemed to have included in the scope of supply all such equipment, accessories, and services necessary to ensure reliable and effective protection of the system, whether or not explicitly specified herein.

In case any requirement of this specification is found to be outdated, ambiguous, or not in line with the latest applicable standards, codes, or proven engineering practices, the Contractor shall bring the same to the notice of the Employer and propose relays conforming to the latest standards and technology, subject to approval by the Employer.

The Contractor shall also comply with any additional functional or performance requirements specified by the Employer during the course of the project, within the overall scope of work. No additional cost claims shall be entertained on this account unless expressly approved by the Employer.

3.6 Power Supply

Each RMU shall be outfitted with a power supply, including batteries and battery charger, suitable for operation of a 5-way RMU even if the RMU, for example, is only 3-way/4-way. This is to allow for the possible addition of future automated VLs. On this basis, the following operational specifications shall apply:

- The power supply unit shall conform to the following requirements:
  - Input: 230 VAC nominal from the RMU's auxiliary power transformer allowing for possible variations from 190 to 300 VAC.
  - Output: Stable 24 VDC for powering Relay, Meter, RTU and motor circuit, etc and 12 VDC for communication accessories.
  - Batteries: 2 Numbers of Lithium Iron Phosphate (LiFePO4) (LFP) 12 VDC, 42Ah each.
  - Each Lithium Iron Phosphate (LiFePO4) battery system shall be provided with an integrated BMS providing: cell voltage and temperature monitoring, state-of-charge and state-of-health estimation, cell balancing, over/under-voltage, over/under- temperature, over-current and short-circuit protection.

- Battery compartment shall feature a theft-proof enclosure of 2mm thick stainless steel (Grade 316, IP54 rated), secured solely by M8 shear-head vandal-proof nuts/bolts. Tamper detection via NC micro-switch on seams/hinges shall trigger a 100 dB piezoelectric hooter with LED strobe (latched, DC-backed), silenced via separate external "Acknowledge" button while retaining LED, and reset via distinct "Reset" button post-rectification; alarms integrate with RTU/SCADA. All wiring, including battery links and sensors, shall use armored cut-proof cables (2.5 sq mm copper with steel braid/sheath resistant to cutters/grinders).
- Receptacles: 2 x 230 VAC (for test equipment)
- Lighting Fixtures shall be provided for Control cabinet.

- The auxiliary power transformer's inputs shall be equipped with surge protection devices with relevant IEC standards.
- The 24 VDC Lithium Iron Phosphate (LiFePO4) batteries shall have sufficient capacity to supply power to the following devices with a nominal backup of 8 hours:
    - RMU's spring-charge motors for a minimum of six (6) operations
    - RMU's trip coils, close coils, FPI, multifunction meters, and relays
    - RTU & Communication Accessories.
- The batteries shall be of Lithium Iron Phosphate (LiFePO4) type and shall have a minimum life of Ten (10) years at 25^{o}C.
- The battery charger shall be fully temperature compensated.
- To prevent deep discharge of the batteries on loss of AC power source, the battery charger shall automatically disconnect all circuitry fed by the batteries following a user- adjustable time period or when the battery voltage falls below a preset value. If the battery voltage falls below the preset value, the time to fully recharge all batteries shall not exceed 8 hours.
- An automatic battery checking device shall be provided to check the battery's health and initiate a battery-failed alarm signal in case battery deterioration is detected. Such detection may be based on comparing measurement values with set values (e.g., internal resistance, voltage, etc.).
- The battery charger shall be provided with an alarm displayed at the local control panel and remotely at the DAS to account for any of the following conditions:
    - Low battery voltage
    - High battery voltage
    - Battery failed
    - Battery charger overvoltage
    - Grounded battery/battery-charger
    - Battery Temperature
    - Others according to manufacturer's design

3.7 Multi-Function Meter

The RMU main incoming and outgoing OD circuits shall be equipped with Intelligent Electronic Devices (IEDs) in the form of communicable multi-function meters capable of providing distribution system voltage, current, power factor, power, power angle, phase angle between voltage and current of all the three phases and energy readings.

3.7.1 Operational Features

The multi-function meters shall have an accuracy class of 0.2 and shall provide data on an RS 485

communications port using the MODBUS protocol.

Each multifunction meter shall have the following minimum features:

- Measurement, display, and communications capability of up to 31 parameters
- THD measurement and power quality data
- True rms measurement
- Digital communications
- Fully programmable PT and CT ratios
- Simple menu driven interface
- High quality LED display
- Able to monitor:

  - Voltage: line-to-line and line-to-neutral
  - Current: phase and neutral
  - Frequency
  - Power factor
  - Power angle
  - phase angle between voltage and current of all the three phases,
  - Power (active, apparent, and reactive)
  - Energy (active and reactive)
  - Total harmonic distortion

3.7.2 Specifications

The following table summarizes the specifications applicable to the multi-function meter.

Table 3-4: Multi-Function Meter Specifications

Parameter	Value
Input Voltage: Nominal input voltage (AC rms) Max continuous input voltage	 57.7 – 277 V L-N, 100 - 480 V L-L 120% of nominal value
Input Current: Nominal input current System CT primary values Max continuous input current	 1 or 5A AC rms (programmable on site) Standard values up to 4 kA (1 or 5 A) 120% of rated value
Overload Withstand: Voltage Current	 2 x rated for 1 sec, repeated 10 times at 10 sec intervals 20 x rated for 1 sec, repeated 5 times at 5 minutes
Operating Measuring Ranges :	
Current	5 to 120% of rated value
Frequency	40 to 70 Hz
Power Factor	0.5 lag to 0.8 lead
Power Angle	Phase Angle Accuracy: **±1** Electrical.
phase angle between voltage and current of all the three phases,	Phase angle accuracy: **±1° to ±2°** (as per IEC 61557 / IEC 62053-22)
Accuracy Reference Conditions: Reference temperature	 23°C ± 2°C

Input waveform	Sinusoidal (distortion factor 0.005)
Input frequency	50 or 60 Hz ±2%
Auxiliary supply voltage	Rated Value ±1%
Auxiliary supply frequency	Rated Value ±1%
Power Factor	0.866 lag to 0.866 lead
Accuracy:	
Voltage	±0.5% over 50 to 100% of rated value
Current	±0.5% over 10 to 100% of rated value
Frequency	0.15% at mid frequency
Active Power	±0.5% over 10 to 100% of rated value
Re-Active Power	±0.5% over 10 to 100% of rated value
Apparent Power	±0.5% over 10 to 100% of rated value
Active Energy (kWh)	1% (IEC 62053-21) from 0.866 lag to 0.866 lead
Reactive Energy (kVArh)	1% (IEC 62053-21) from 0.866 lag to 0.866 lead
Apparent Energy (kVAh)	1%
Phase Angle and Power Factor	1 %
Applicable Standards:	
Comprehensive EMC/ Immunity	IEC 61000-4 series
Safety	IEC 61010-1-2010+A1:2016
IP for water and dust	IEC 60529
Environmental:	
Operating temperature	-10 to +55°C
Relative humidity	0 to 90% non-condensing

3.8 Cyber security Requirements for RMUs Protection & Metering:

3.8.1 General Compliance

The Vendor shall ensure that all Intelligent Electronic Devices (IEDs), including protective relays and multifunction meters, are designed and manufactured in accordance with the following international standards:

IEC 62443-4-1: Secure Product Development Lifecycle Requirements.

IEC 62443-4-2: Technical Security Requirements for IACS Components (Target: Capability Security Level 1 - SL1).

IEC 62351: Power systems management and associated information exchange – Data and communications security.

3.8.2 Identification and Authentication Control (IAC)

Local Authentication: The device must support local password-based authentication for both the HMI (Human Machine Interface) and any engineering ports (USB/RS-485/Ethernet).

Default Credentials: The device shall not have "hard-coded" or universal passwords. The Vendor must provide a mechanism to force a change of the factory-default password during the commissioning and also allow changing passwords.

Access Lockout: The device shall implement a temporary lockout or "cool-down" period after a configurable number of failed authentication attempts (Min: 3 attempts) to prevent brute-force attacks via the engineering port.

3.8.3 Use Control and Port Security (UC)

USB Port Management: The relay must disable "Autorun" or "Autoplay" functionality. No configuration file or firmware shall be executed or imported automatically upon USB insertion.

Manual Confirmation: Any data transfer (Upload/Download) via the USB interface must require explicit manual confirmation through the device's HMI after successful login.

Unused Ports: The vendor shall provide the capability to logically disable unused communication ports (e.g., RS-485 or Ethernet) via the device configuration settings.

3.8.4 System Integrity (SI)

Firmware Integrity: The device must perform a cryptographic checksum (e.g., SHA- 256) or hash verification on all firmware updates before installation to ensure the file has not been tampered with.

Logic Protection: Protection settings, trip logic, and configuration parameters must be stored in a non-volatile memory that is protected against unauthorized modification.

3.8.5 Audit Logging and Monitoring (RA)

Security Event Logging: The device shall maintain an internal, non-volatile audit log that records at least the last 50 security-relevant events, including:

Successful and failed login attempts.

USB/Engineering port connection and disconnection events.

Modifications to protection settings or system configurations.

Firmware update attempts (Success/Failure).

Exportability: Log data must be viewable via the engineering software and, if network-enabled, exportable via standard protocols (e.g., Syslog or IEC 61850).

3.8.6 Vendor Documentation Requirements

The Vendor shall submit the following documents as part of the technical bid:

Hardening Guide: A step-by-step document explaining how to secure the device (e.g., changing passwords, disabling ports).

Vulnerability Management Policy: A statement on how the vendor identifies and notifies customers of security vulnerabilities (CVEs) in their products.

Self-Attestation: A formal letter confirming that the device meets the Capability Security Level 1 (SL-C 1) requirements of IEC 62443-4-2.

3.9 Distribution Automation System Interface

The RMU shall be equipped so that it can be monitored and controlled via the DAS. In this respect, it shall interoperate with the RTU that will be housed in the RMU Control Cabinet. The RTU in turn will interoperate with the DAS via the communications system which is linked.

The RMU shall have provisions for opening and closing its switches using output from the RTU. The RMU shall also supply analog and status signals to the RTU for monitoring the condition of the RMU's distribution network circuits as well as the components of the RMU. A DI indication for execution of DO command to RTU for open and close for all switches shall be

Provided. A list of input/output points required for 3-way 4-way and 5-way RMU configurations is presented in Table 3-5 below.

Table 3-5: Data Points per RMU Configuration

DIGITAL INPUT	CONTROL OUTPUT	IED DATA
LBS 1 ▪ LBS 1: closed ▪ LBS 1: open ▪ LBS 1: VPIS Indication ▪ LBS 1 Earth switch: closed ▪ LBS 1 Earth switch: open ▪ LBS 1 L/R switch local status ▪ LBS 1 Cable entry Door: open ▪ DI indication for execution of DO command for open and close of LBS 1 **LBS 2** ▪ LBS 2: closed ▪ LBS 2: open ▪ LBS 2: VPIS Indication ▪ LBS 2 Earth switch: closed ▪ LBS 2 Earth switch: open ▪ LBS 2 L/R switch local status LBS 2 Cable entry Door: open ▪ DI indication for execution of DO command for open and close of LBS 2 FPI ▪ Overcurrent operated ▪ Earth fault operated	**LBS 1** ▪ LBS 1: close ▪ LBS 1: open **LBS 2** ▪ LBS 2: close ▪ LBS 2: open **CB 1** ▪ CB 1: close ▪ CB 1: open **CB 2** ▪ CB 2: close ▪ CB 2: open **CB 3** ▪ CB 3: close ▪ CB 3: open **FPI** ▪ FPI Reset **Miscellaneous:** ▪ Hooter Reset **Total: 12** **Total (with spares): 16**	Multifunction Meters communications on MODBUS through RS485 ports (2 meters) No. of Measurements: ▪ Voltage: 6 ▪ Current: 6 ▪ Active power: 2 ▪ Reactive power: 2 ▪ Power factor: 2 ▪ Active Energy: 2 ▪ Reactive Energy: 2 ▪ Phase angle current: 6 ▪ % THD: 2 **Total Measurements: 30** Feeder Protection Relays communications on MODBUS through RS485 ports (up to 3 protection relays) Minimum No. of Points: ▪ Phase Current: 9 ▪ Fault current: 9 ▪ EFR Fault current: 3 ▪ Relay Ie Earth Current: 3 ▪ Relay Fault Type: 3 ▪ Relay Trip Time: 3 (Time taken for relay and breaker operation during fault event) ▪ Relay Group A/B Active: 3 ▪ Relay Reset mode Local/Auto: 3 ▪ Circuit Breaker Failure Protection: 3 ▪ Relay OCR operated: 3 ▪ Relay EFR operated: 3

DIGITAL INPUT	CONTROL OUTPUT	IED DATA
CB1 ▪ CB 1: closed ▪ CB 1: open ▪ CB 1 Spring/Motor: charged ▪ CB 1 Earth switch: closed ▪ CB 1 Earth switch: open ▪ CB 1 L/R switch local status ▪ CB 1 Cable Entry Door: open ▪ CB 1 Disconnector status: open/close ▪ CB 1: VPIS Indication ▪ DI indication for execution of DO command for open and close of CB 1 **CB2** ▪ CB 2: closed ▪ CB 2: open ▪ CB 2 Spring/Motor: charged ▪ CB 2 Earth switch: closed ▪ CB 2 Earth switch: open ▪ CB 2 L/R switch local status ▪ CB 2 Cable Entry Door: open ▪ CB 2 Disconnector status: open/close ▪ CB 2: VPIS Indication ▪ DI indication for execution of DO command for open and close of CB 2 **CB3** ▪ CB 3: closed ▪ CB 3: open ▪ CB 3 Spring/Motor: charged ▪ CB 3 Earth switch: closed ▪ CB 3 Earth switch: open ▪ CB 3 L/R switch local status ▪ CB 3 Cable Entry Door: open ▪ CB 3 Disconnector status: open/close ▪ CB 3: VPIS Indication ▪ DI indication for execution of DO command for open and close of CB 3 **Miscellaneous:** ▪ SF6 Pressure: Low ▪ Charger AC: Fail		▪ Relay group change A/B: 3 ▪ Relay reset mode change: local/ auto: 3 ▪ Relay reset OCR/EFR: 3 ▪ RTC Time Sync with Relay: 3 ▪ Low set Settings for OCR and EFR: 3 ▪ High set Settings for OCR and EFR: 3 **Total Points: 63**

DIGITAL INPUT	CONTROL OUTPUT	IED DATA
▪ Voltage DC: Low ▪ Battery: fail ▪ CC Door: open ▪ Battery Compartment Door Open ▪ Battery temperature General: ▪ Dummy Latching Relay Open/Close ▪ RTU Local/Remote Status ▪ RTU Door Open **Total: 58** **Total (with spares): 64** Soft signals: ▪ Meter Offline: 2 ▪ Relay Offline: 3 ▪ DI point for DO execution of RMU		

3.9.1 Multi-Function Meter Interface with RTU

The Contractor is required to furnish the RMU meter information that pertains to interfacing the meter with the RTU through an RS-485 serial communications link. The protocol details along with the MODBUS mapping data as implemented in each meter shall be provided (MODBUS mapping data will be provided by BESCOM, same shall be implemented in MFM). In this respect, the Contractor in cooperation and coordination with the RTU contractor shall share the responsibility of ensuring effective communications is attained between the meter and RTU, i.e., all parameters read by the meters shall also be immediately available to the RTU.

3.9.2 Numerical Relay Interface with RTU

The Contractor is required to furnish the numerical relay information that pertains to interfacing the relay with the RTU through an RS 485 serial communications link. The protocol details along with the MODBUS mapping data as implemented in each relay shall be provided (MODBUS mapping data will be provided by BESCOM, same shall be implemented in Relay). In this respect, the Contractor in cooperation and coordination with the RTU contractor shall share the responsibility of ensuring effective communications is attained between the relay and RTU, i.e., all parameters read by the relay shall also be immediately available to the RTU.

3.10 Construction

The RMU shall be sufficiently sturdy to withstand handling during shipment, installation, and start-up without damage. The configuration for shipment shall adequately protect the RMU equipment from scraping, banging, or any other damage. The Contractor shall assume responsibility for correction of all such damage prior to final acceptance of the equipment.

3.11 Enclosures

All the enclosures shall be sized to provide convenient access to all enclosed components. It shall not be necessary to remove any component to gain access to another component for maintenance purposes or any other reason.

The enclosures shall also be designed to ensure that the enclosure remains rigid and retains its structural integrity under all operating and service conditions with and without the enclosure door closed.

If made from stainless steel (316L), the thickness of the enclosure panels shall be at least 1.5 mm. Otherwise the thickness of all enclosure panels shall be at least 2 mm.

The appropriate corrosion treatment and finish requirements shall apply to both inside and outside enclosure surfaces. Other required features are as follows:

- Constructed of stainless steel (316L) according to IEC 60529 with IP rating 56 or better. And can withstand external mechanical shocks not less than IK10 as per applicable IEC standards. Alternatively, the RMU metal parts shall be made of high thickness high tensile steel/CRCA which must be grit/shot blasted, thermally sprayed with Zinc alloy, phosphate, and subsequently painted with polyurethane based powder paint, the overall paint layer thickness including Zinc spraying shall be of the order of 120 microns.
- Means, such as insulated heat shields and/or air vents, to prevent high temperatures from damaging the RMUs enclosed components. If air vents are installed, these vents shall in no way reduce the effectiveness of the enclosure's protective characteristics.
- A metal pocket attached to the inside of the control cabinet door to hold documentation, maintenance log sheets, and other such information.
- Door opening mechanism with built-in key-lock facility shall be provided. An opening mechanism that is less prone to breaking than a projecting door handle is preferred, e.g., a push-button opening mechanism.
- A grounding terminal including grounding bolt and lock washer for connecting a 50 mm^2 galvanized steel grounding conductor. The grounding bolt and lock washer shall be made of stainless steel.
- Means of preventing moisture from condensing on electronic components mounted inside the enclosure proposed for housing the RTU. If necessary, heaters providing adjustable thermostat-control within the range 20 to 60 ºC shall be installed in the enclosure for this purpose.
- Means of protection against rain water, corrosive salt formations, and high levels of airborne dust.
- Means of enabling the DAS to monitor the open/closed status of the enclosure door.

3.12 Control Cabinet

The RMU shall be outfitted with a separate enclosure, referred to herein as the Control Cabinet, to house the following equipment as a minimum:

- Auxiliary transformer
- SCADA terminal blocks

- Power Supply Unit including Charger and Batteries
- RTU
- Communication system
- Multi-pin connector consisting of plug and socket fittings and angled terminal block
- Other equipment according to manufacturer's design

The Control Cabinet shall be similar in style and finish as the other RMU enclosures. This shall include having a minimum protection class of IP 56 or better and can with stand external mechanical shocks not less than IK10 as per IEC62262 standards

The cabinet shall have a hinged front access door with a three-point latch locking system and a latch operating lockable handle. The door shall be fitted with a perimeter flange and gasket (rubber or neoprene) to prevent the entrance of water. In addition, a means of monitoring and indicating that the door is open shall be provided.

A metal screen with holes shall be provided on the top and bottom of the control cabinet to provide ventilation aimed at avoiding condensation inside. Venting however shall in no way reduce the effectiveness of the control cabinet's water-tight, dust-tight, and corrosion-resistant characteristics. To augment the cabinet's effectiveness in preventing the ingress of dust, insects, vermin, and small objects, all electronic parts within the control cabinet shall be enclosed in modules. Such parts and modules shall be separated from the power supply modules as also installed in the cabinet.

The Control Cabinet shall provide sealed box at height of 40 Inches from the base of RMU and 5 inches from the front side of RMU for routing an antenna cable. The sealed box shall include 2 nos of weather -sealed hole with a double compression cable gland, approximately 25 mm in diameter, on the top of the cabinet for routing an antenna cable that will be supplied and installed by BESCOM.

If made from stainless steel (316L), the thickness of the enclosure panels shall be at least 1.5 mm. Otherwise the thickness of all enclosure panels shall be at least 2 mm.

The control cabinet shall also be provided with:

- Weatherproof fittings for control cables.
- A number lock/Digital lock of adequate size shall be provided
- Grounding terminal, with solderless clamp type connector suitable for steel stranded conductor of suitable diameter and complete with lock washer of stainless steel or better.
- Provision for separately grounding the RMU's electronic items.
- Thermally controlled small fan for circulating air when necessary to maintain temperatures within the Control Cabinet to acceptable levels.
- Circuit diagram of control unit for maintenance purpose affixed permanently.
- Others according to manufacturer's design.

3.13 Auxiliary Transformer

The RMU shall be outfitted with a single-phase auxiliary power transformer with a turns ratio of 11000/sqrt (3) to 230V, i.e., it shall be connected line-to-neutral to the RMU 11 kV bus and used to provide the required 230 VAC input to the RMU's power supply. The auxiliary power transformer shall have a capacity of at least 1,000 VA., the auxiliary transformer must be capable of supporting the power supply requirements that correspond to a 5-way RMU. HRC fuses shall be provided on both the HV and LV sides of the transformer.

3.14 Motors

The RMU shall be retro-fitted with spring charge motors of insulation Class E or better allowing the circuit breakers and load break switches to be operated without manual intervention. Motor speed shall ensure springs can be charged automatically. Independently of DAS control, the mechanism shall ensure that the motors start up immediately once the spring becomes discharged, so that the breaker becomes ready for the next operation.

The motors along with a Contractor supplied control panel shall allow Employer personnel to electrically operate the circuit breakers and also load break switches at site without any modification of the operating mechanism and without de-energizing the RMU.

The motors shall be of a reputable make in the form of a universal 24 VDC type. They shall be enclosed and completely dust proof and sized with a suitable margin to meet the torque requirement of the spring charge mechanism. The Motors shall be located within the RMU enclosures.